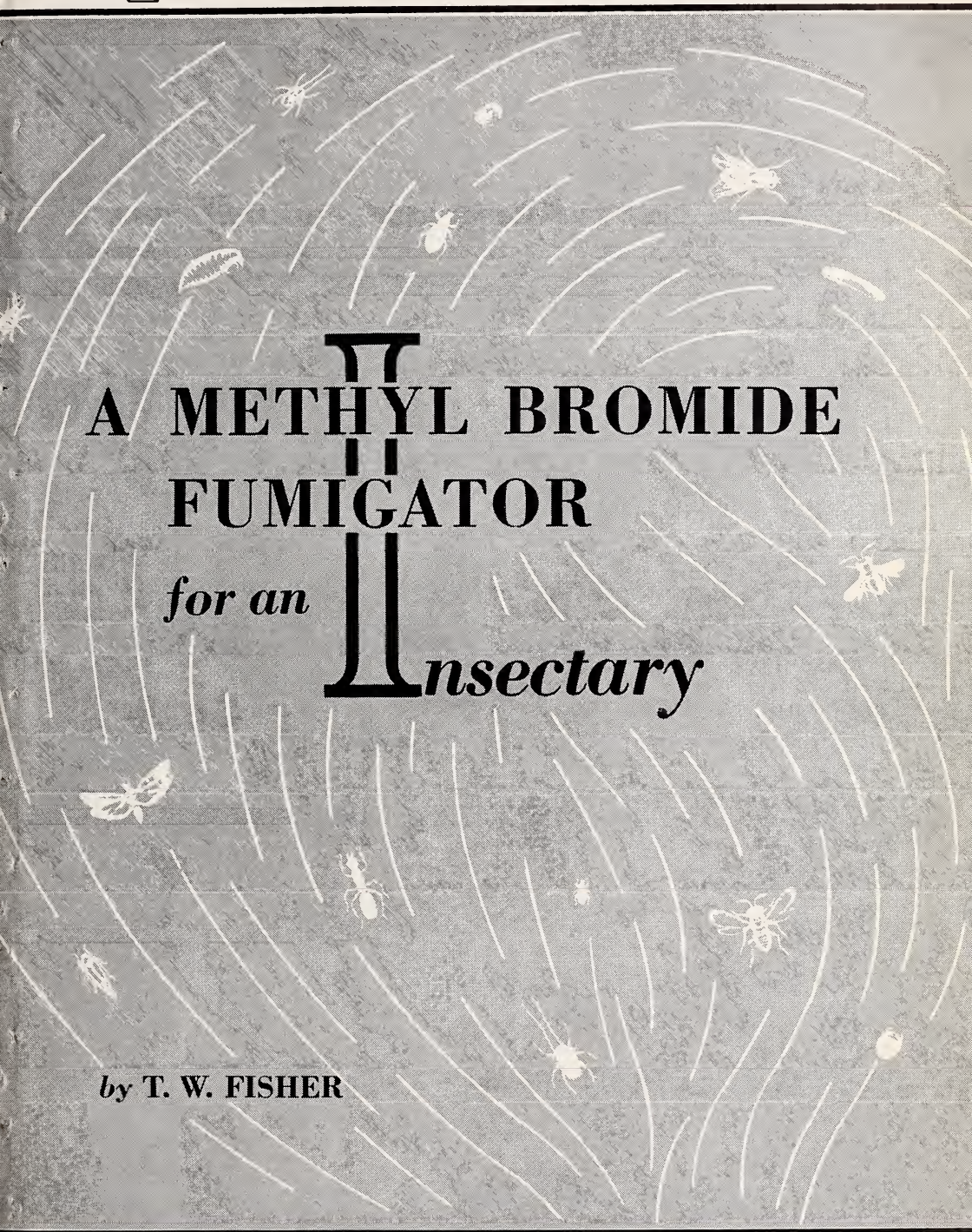
Division of Agricultural Sciences
UNIVERSITY OF CALIFORNIA



A METHYL BROMIDE FUMIGATOR for an Insectary

by T. W. FISHER

CALIFORNIA AGRICULTURAL
Experiment Station
Extension Service

CIRCULAR 520

A METHYL BROMIDE FUMIGATOR *for an Insectary*

An efficient fumigator is necessary to the insectary program because it ensures that cultures of insects can be initiated free of competing, or contaminating, species. This is of particular importance in the mass production of entomophagous insects, which requires clean host insects on clean host plants.

The atmospheric fumigator described in this circular was designed specifically for the insectary at Riverside, but the plans can be used by nurserymen and quarantine workers as well as by entomologists concerned with design and construction of insectary facilities.

FEBRUARY, 1963

The Author: T. W. Fisher is *Assistant Entomologist* in the Department of Biological Control, Agricultural Experiment Station, Riverside.

The California State Department of Agriculture Bureau of Entomology has conducted tests to establish plant tolerances of various fumigants at dosages that will achieve 100 per cent insect kill. The Bureau's findings, with lists of host plants tolerant and non-tolerant of methyl bromide are given on pages 19–20.

Treatment time and dosage will, of course, be determined by the arthropod species to be eradicated.

GENERAL DESCRIPTION

Exterior measurements: 6′8″ × 6′8″ × 7′10½″. The inside chamber measures 6′ × 6′ × 7′ and has a volume of approximately 250 cubic feet (convenient for converting recommended dosages, most of which are on the basis of 1,000 cubic feet).

All controls are located at the front of the box, for convenience and efficiency.

Humidification apparatus is included so that living plants can be fumigated safely. This makes possible any type of fumigation with any fumigant (see "Caution," p. 17) ordinarily required in insectary operation. Furthermore, this feature qualifies the equipment for certification, as an "approved fumigator," by the California State Department of Agriculture (see p. 12).

Plumbing. Exclusive of through-wall fittings on the front of the box, plumbing consists of a 1½-inch floor drain with gas-tight cap, located outside and beneath the fumigator box at its front left corner.

Electric power supply consists of 208 volts in two circuits of 20 amperes capacity each. It was necessary to bring 208 volts to the strip heaters in order for them to function properly. The load to the other electrical components is divided between the two 115-volt legs of the primary power supply.

Cost of the fumigator was $2,300 for labor and materials, in 1956, at Riverside. In 1961, estimated cost was $2,800, including a few modifications of the 1956 model as described here.

BILL OF MATERIALS

Lumber

Top Section

Materials:

4 - 1⅜″ × 3¼″ × 6′7″ end stiles select Douglas fir
3 - 1⅜″ × 3¼″ × 6′3½″ center stile
2 - 1⅜″ × 3¼″ × 44″ top and bottom rail
2 - 1⅜″ × 3¼″ × 28″ top and bottom rail

Construction: Top section, or ceiling, is made up of two frames, 1⅜″ × 47½″ × 6′7″ and a third frame, 1⅜″ × 31½″ × 6′7″. These frames were mortised and tenoned together.

Wall Section

Materials:

2 - 3¼″ × 6″ posts for doorway section
40 - 1⅜″ × 3¼″ × 6′4¾″ studs for walls
1 - 3¼″ × 6″ × 58″ header for doorwall section
1 - 1⅜″ × 3¼″ × 58″ plate for doorwall section
6 - 1⅜″ × 3¼″ × 47″ plates for sides and back wall
4 - 1⅜″ × 3¼″ × 8½″ plates for corner on front of box
4 - 1⅜″ × 3¼″ × 10½″ plates for corner on front of box
4 - 1⅜″ × 3¼″ × 6½″ plates for corner on back of box
4 - 1⅜″ × 3¼″ × 23½″ plates for corner on back of box
4 - 1⅜″ × 3¼″ × 9½″ plates for the two small rear sections of box

Construction: Throughout the box, studs are gained ¼″ into top and bottom plates. Sixteen-penny box nails were used and two #10 × 2-inch flat-head wood screws were used to hold each stud in place. Approximately 350 #10 × 2-inch flat-head wood screws were used.

All panel sections of walls, base, and

top are bolted together with ½ × 3-inch lag screws threaded into a cast-iron fastener, called a connecting pod (Kason No. 1177, Kason Hardware Corp., Brooklyn, N.Y.). Approximately 74 lag screws and connecting pods were used throughout the box.

Base Section

Materials:

4 - 1⅜″ × 5⅜″ × 6′7″ floor joists
10 - 1⅜″ × 5⅜″ × 17″ floor joists
8 - 1⅜″ × 3¼″ × 6′7″ plates, halved together
18 - 1⅜″ × 3¼″ × 8⅞″ studs halved to receive 1⅜″ × 5⅜″ floor joist
4 - 3¼″ × 5½″ × 8⅞″ corner posts
4 - 1⅜″ × 3¼″ × 8⅞″ corner posts
1 - ½″ exterior plywood panel 42½″ × 72″ (subfloor)
1 - ½″ exterior plywood panel 30¼″ × 72″ (subfloor)

Construction: This section was made up in a unit 6′7″ × 6′7″ with 5″ sides (inside measurements) extending from floor. Studs were fastened to floor joist with ⅜″ × 2½″ carriage bolts. Approximately 3 dozen were used.

Armorply Interior

11 sheets ¼″ × 48″ × 84″ exterior Douglas fir plywood faced one side with 24-gauge Republic Paintlock zinc bond Armorply (U. S. Plywood Corp.). (Includes door.)

Armorply Exterior

8 sheets ¼″ × 48″ × 96″ exterior Douglas fir plywood faced one side with .025-3003 H 14 mill finish aluminum Armorply. (Includes door.)

2 sheets ¼″ × 48″ × 84″ same as above.

False-floor Joists

Materials: 8 redwood 1″ × 5½″, varying lengths

Construction: Grated birch flooring is supported 5½″ above Armorply floor surface by fan-shaped redwood frame in two 71″ × 35″ sections, making it possible to remove for cleaning.

Grate (Duckboards)

Materials: 52 birch slats ¾″ × 1⅝″ × 71½″.

Construction: Grate which forms floor section is made in three 1⅝″ × 23″ × 71½″ sections easily removed for cleaning. Grates are of birch stock for strength and durability.

Door

Framework:

Beveled frame—(mill to specific detail)
2 - 3″ × 4″ × 72″ select Douglas fir
2 - 3″ × 4″ × 36″ select Douglas fir
3 - 4″ × 4″ × 36″ select Douglas fir
Face frame—(mortise and tenon)
2 - 1″ × 4″ × 72″ select Douglas fir, stiles
5 - 1″ × 5″ × 33″ select Douglas fir, rails

Hardware Items:

3 - steel strap hinges (Kason No. 1074)
1 - latch, heavy duty (Kason No. K-54A)
2 - wedge-type levers (Kason No. 878)
40 feet - innerseal gasket, spring wire reinforced (Kason No. 285)

Insulation: Approximately 100 square feet of 3″ rock wool batts in top and walls; 45 board feet of 1″ fiberglass in door.

Valves

1 - 3½″ irrigation valve (air inlet valve, fig. 3, A)
1 - 4″ gate valve, Chapman (exhaust valve, fig. 3, K)
2 - gas cocks, Mueller, ⅜″ pipe thread (metering valves, fig. 3, L)

Electrical

Exterior

4 - switches, weatherproof boxes with pilot lights
1 - switch, weatherproof
1 - duplex receptacle, weatherproof
1 - relay, Allen Bradley 110V control coil, 220V double-pole single-throw
1 - exhaust fan, 5½″ × 8″ diameter, squirrel-cage type
1 - motor, ⅓ H.P., 1725 rpm

1 - alarm bell, Edwards Co., No. 340 Adaptabel
½″ conduit to junction box (12 feet in this installation)
Miscellaneous fittings—tees, Y's, nipples, etc.

Interior

1 - light, VG 175-115 condulet
2 - switches (alarm bell and light)
1 - recirculating fan, Tradewind, 100 cfm
2 - strip heaters, Chromalox, Edwin L. Weig & Co., Pittsburgh, Pa.
1 - immersion heater, 110-125V AC
5 feet - ½″ conduit
Miscellaneous fittings

Plumbing

1 - 1½″ standard sink drain
2 - ½″ × 6″ nipples

Sheet Metal

Interior Ducts

1 - 6″ × 6″ × 6′ (contains strip heaters)
1 - 3″ × 6′ downspout (recirculation duct)

Exhaust Stack

1 - 6″ × 10′ stovepipe
4 - 10′ guy wires

Miscellaneous

1 - threshold, hinged steel ramp, 34″ × 17″ of ¼″ steel
1 - methyl bromide applicator, Arrow Products Co., Carlstadt, N.J.
1 - thermometer, Weksler Thermometer Works, New York
74 - connecting pods (see wall construction)
74 - ½″ × 3″ lag screws
4 - ¾″ × 8′ eye bolts

CONSTRUCTION

The box and door must be extremely rigid in construction to prevent possible warping due to atmospheric changes. This is particularly important for equipment that is to hold gas. In addition, all through-wall fittings, such as electric conduit, thermometer, metering valves, and so forth, must be thoroughly caulked and gasketed.

The initial cost required to build a completely gas-tight box will be more than compensated for by reduced maintenance problems during the life of the equipment.

(Certain construction items actually used in the fumigator at Riverside are indicated by trade names. Since the illustrations will suggest the general type of equipment needed, lists of other acceptable models or makes were not considered necessary to an understanding of the principles involved in the construction of an efficient fumigator.)

Framework (fig. 1) is of 2″ × 4″ lumber, built in three parts. The top and chamber were constructed separately and bolted together after the interior covering was glued into position. This method greatly strengthened the seams. For the base, a subfloor of ½-inch plywood was laid on 2″ × 6″ finished joists (shown in base list as 1⅜″ × 5⅜″). Over this, ¼-inch galvanized Armorply was cemented with its edges folded up to form a pan 72″ × 72″ × 8″ deep. After its plywood base was removed, the metal layer of the Armorply was folded over the top plate of the base section, and over the bottom plate of the chamber section (fig. 2) so that the metal layers were held in contact between the plates. These two plates were then bolted together in the same way as the vertical members, to insure an immobile seam.

Interior covering is galvanized steel bonded to ¼-inch plywood (Armorply).

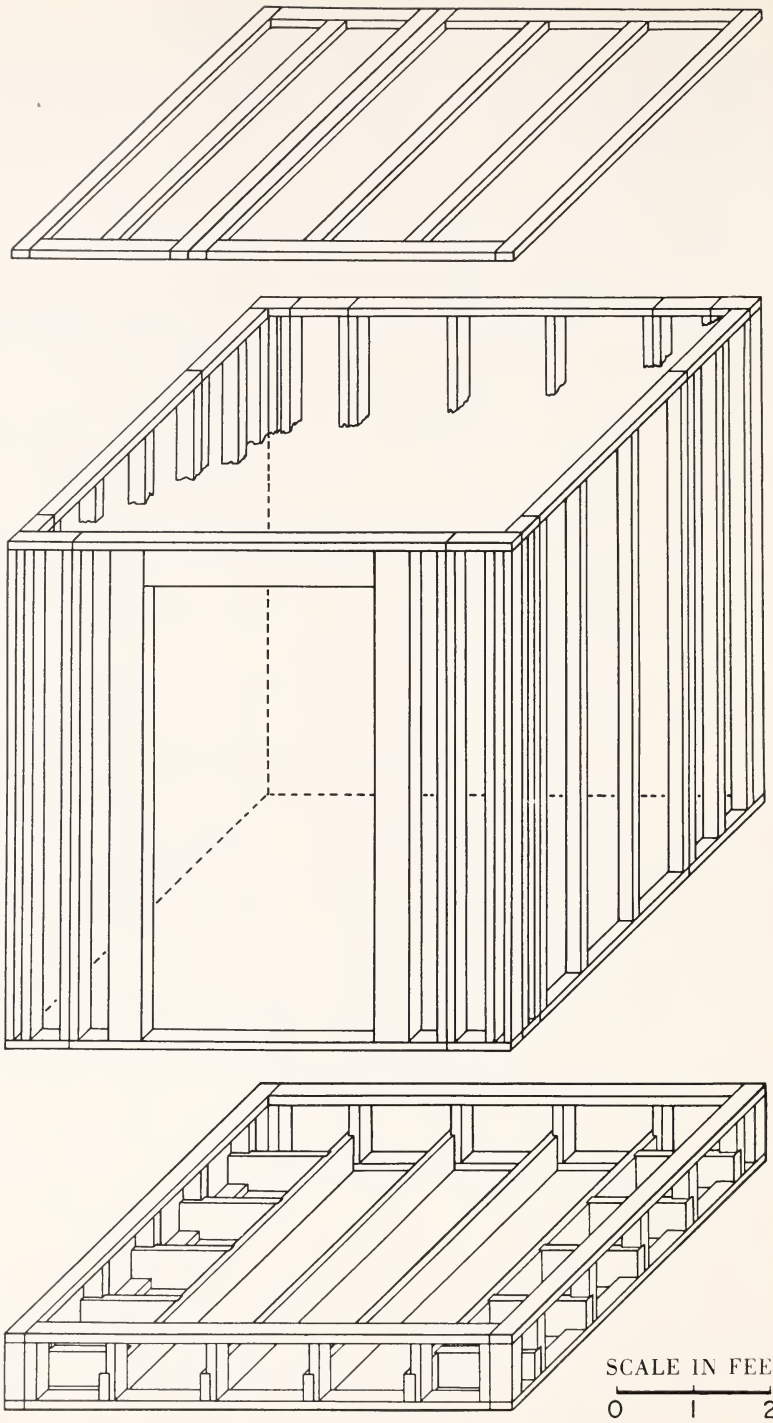


Figure 1. Framework of fumigator—top, chamber, and base. Breaks in top plate of chamber indicate points at which edges of adjoining sheets of Armorply are held together. See fig. 2 for detail.)

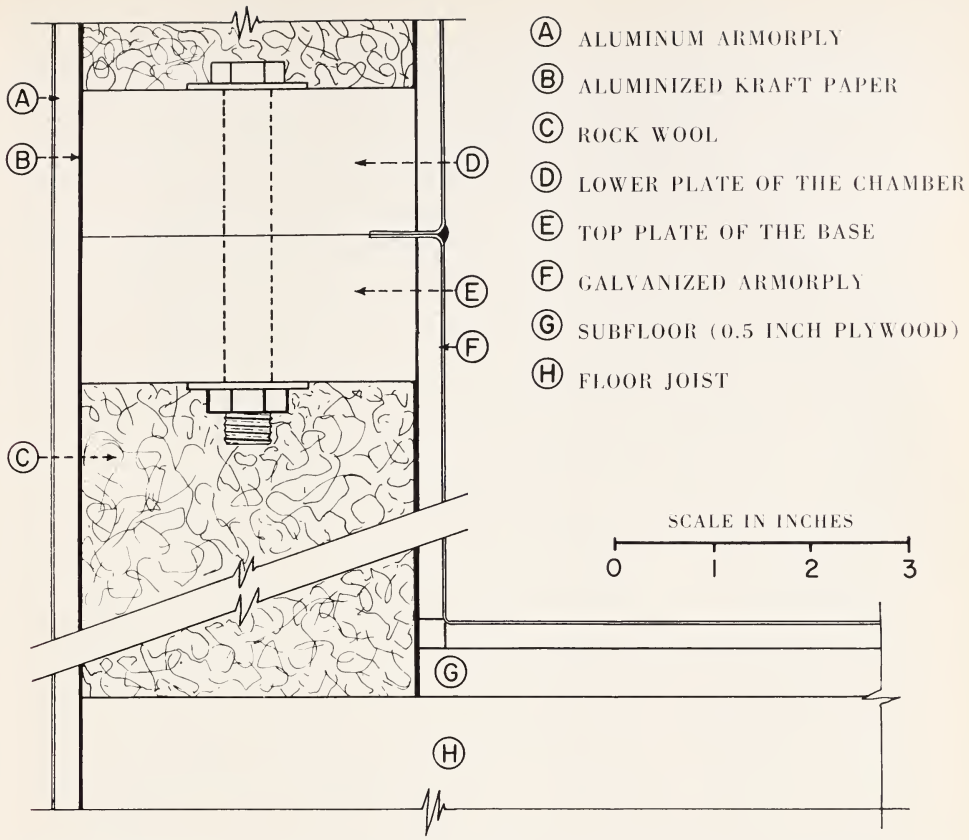

A ALUMINUM ARMORPLY
B ALUMINIZED KRAFT PAPER
C ROCK WOOL
D LOWER PLATE OF THE CHAMBER
E TOP PLATE OF THE BASE
F GALVANIZED ARMORPLY
G SUBFLOOR (0.5 INCH PLYWOOD)
H FLOOR JOIST
SCALE IN INCHES
0 1 2 3

Figure 2. **Partial detail through wall of chamber and base (pan). Strip of plywood backing is removed along edge of Armorply. Exposed metal is then bent at right angle across plywood. Metal surfaces are thus sandwiched between vertical studs and horizontal plates which are bolted together to form tight seam. Seams are then soldered. (See detail, D to E.)**

It is attached to the frame with Weldwood glue, and all seams are soldered. The bolted framework prevents movement of the plywood walls. Interior walls are painted with automotive enamel (synthetic) to prevent corrosion of the lining.

Exterior covering is aluminum bonded to ¼-inch plywood (Armorply), fastened to the framework by ¾-inch sheetmetal screws. All seams are sealed with a mastic compound. Before the exterior was covered, batts of rock wool were placed between the boards forming the top and sides, and a layer of aluminized Kraft paper for further vapor sealing and insulating was placed over the framework.

The finished box is sufficiently rigid to permit moving either by forklift, under the skids, or by crane hoist, using heavy eye bolts that extend the entire height of the box at each corner, and are held in place by washers and nuts countersunk into the bottom of the skids.

Figure 5. Door open to show double gaskets. Steel loading ramp is pulled up when door is to be closed.

Figure 6. Partial view of interior. Inside the chamber, at left of doorway (not shown in photo) are thermostat, light, double switch for the light, and the alarm bell. Electric switches and heaters may safely be placed in an atmosphere of methyl bromide gas at sub-explosive concentrations of the fumigant used for insectary fumigation (2 lb. per 1,000 cu. ft.).

R. Duct containing two 1,000-watt finned strip heaters. (Inspection plate removed to show heaters.) When exhaust valve (K, fig. 3) is closed, air is forced through duct via interior section of duct J (fig. 3) by recirculation fan W (fig. 7). Air leaves heater duct via holes shown.

S. Removable hardwood duckboards, in three sections, rest on removable false-floor joists, in two sections, which converge toward re-circulation of fan W (fig. 7). Duckboards plus supporting joists of chemically-treated redwood make 8-inch false floor, or pan below threshold (see figs. 1 and 2).

T. Steel loading ramp attached to front of duckboard by hinges folds back to allow door to close (see fig. 5). Stops inside support ramp when it is up; stops on ramp prevent door's closing when ramp is down.

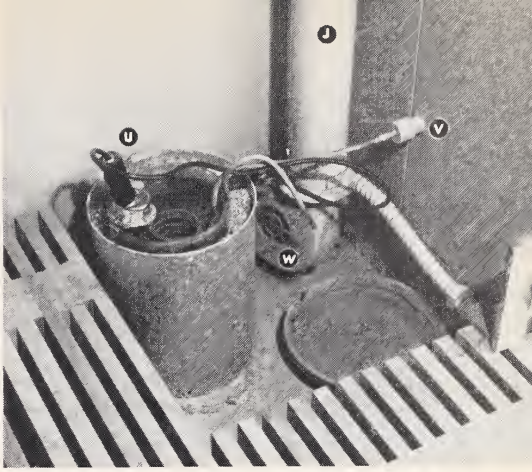


Figure 7. Recirculation fan and humidification equipment.
U. Water is heated by water heater. Thermostat on heater keeps temperature between 160° and 180° F. If temperature goes higher, water boils off. Fumigant enters at V and is changed from liquid to gas as it passes through 5/16-inch copper tube coiled in bath. Open end of tube is bent over edge of bath so that free methyl bromide gas is pulled into recirculation fan, W, and chamber quickly receives uniform dosage. Any nonvolatilized fumigant falls into ceramic dish below open tube, and as it becomes gaseous is also sucked into fan.

Hot water also provides necessary humidity (75 per cent minimum) to prevent injury to living plant material. Water container is standard 1-gallon battery jar surrounded by insulating layer of vermiculite in galvanized container. Water must be added before start of each fumigation cycle. Tests with a recording hygrothermograph placed in box with steam bath going indicated relative humidity in excess of 80 per cent. If it were necessary to check humidity during a fumigation cycle, tubing could be attached to valves provided for the fumigant-metering machine, and air from box could be passed through a small chamber containing a wet-dry bulb. For absolute accuracy, a corrosive-resistant sensing element can be placed in the box, and the wire leads run to an electronic hygrometer. (Such a device was used to check the efficiency of the box described here.)

In larger fumigators, humidity is provided either by a steam vaporizer, employing electrodes submerged in water, or by atomizing nozzles.

W. 100-CFM (cu. ft. per minute) recirculation fan prevents stratification of gas by running continuously during fumigating or exhausting. Heater can be shut off during exhaust cycle, while fan continues to run.

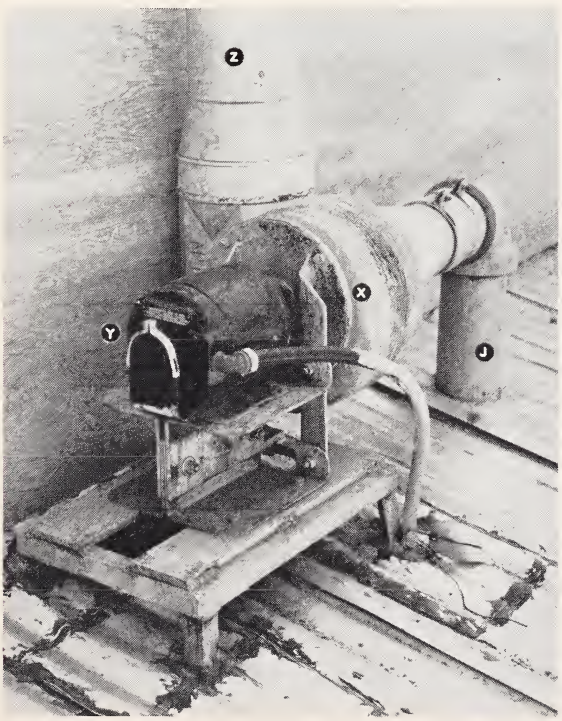


Figure 8. Exhaust fan on roof that shelters fumigator.
X. Squirrel-cage fan, 250 CFM capacity.
Y. 1/3-horsepower motor for fan.
Z. Exhaust stack, 6 inches in diameter, 10 feet in height. Duct J is continuation of duct shown in figure 4. Stack should discharge fumes well above nearby buildings.

Figure 5. Door open to show double gaskets. Steel loading ramp is pulled up when door is to be closed.

Figure 6. Partial view of interior. Inside the chamber, at left of doorway (not shown in photo) are thermostat, light, double switch for the light, and the alarm bell. Electric switches and heaters may safely be placed in an atmosphere of methyl bromide gas at sub-explosive concentrations of the fumigant used for insectary fumigation (2 lb. per 1,000 cu. ft.).

R. Duct containing two 1,000-watt finned strip heaters. (Inspection plate removed to show heaters.) When exhaust valve (K, fig. 3) is closed, air is forced through duct via interior section of duct J (fig. 3) by recirculation fan W (fig. 7). Air leaves heater duct via holes shown.

S. Removable hardwood duckboards, in three sections, rest on removable false-floor joists, in two sections, which converge toward re-circulation of fan W (fig. 7). Duckboards plus supporting joists of chemically-treated redwood make 8-inch false floor, or pan below threshold (see figs. 1 and 2).

T. Steel loading ramp attached to front of duckboard by hinges folds back to allow door to close (see fig. 5). Stops inside support ramp when it is up; stops on ramp prevent door's closing when ramp is down.

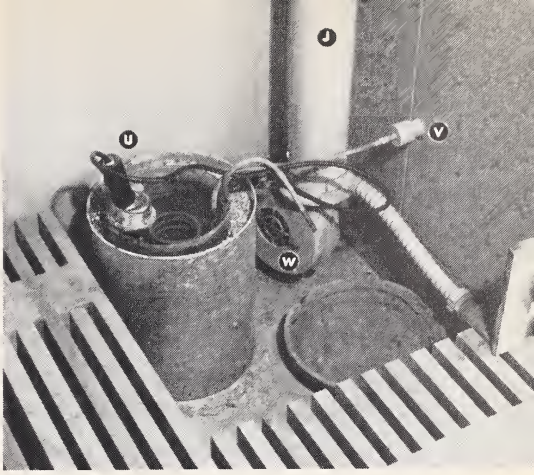


Figure 7. Recirculation fan and humidification equipment.
U. Water is heated by water heater. Thermostat on heater keeps temperature between 160° and 180° F. If temperature goes higher, water boils off. Fumigant enters at V and is changed from liquid to gas as it passes through 5/16-inch copper tube coiled in bath. Open end of tube is bent over edge of bath so that free methyl bromide gas is pulled into recirculation fan, W, and chamber quickly receives uniform dosage. Any nonvolatilized fumigant falls into ceramic dish below open tube, and as it becomes gaseous is also sucked into fan.

Hot water also provides necessary humidity (75 per cent minimum) to prevent injury to living plant material. Water container is standard 1-gallon battery jar surrounded by insulating layer of vermiculite in galvanized container. Water must be added before start of each fumigation cycle. Tests with a recording hygrothermograph placed in box with steam bath going indicated relative humidity in excess of 80 per cent. If it were necessary to check humidity during a fumigation cycle, tubing could be attached to valves provided for the fumigant-metering machine, and air from box could be passed through a small chamber containing a wet-dry bulb. For absolute accuracy, a corrosive-resistant sensing element can be placed in the box, and the wire leads run to an electronic hygrometer. (Such a device was used to check the efficiency of the box described here.)

In larger fumigators, humidity is provided either by a steam vaporizer, employing electrodes submerged in water, or by atomizing nozzles.

W. 100-CFM (cu. ft. per minute) recirculation fan prevents stratification of gas by running continuously during fumigating or exhausting. Heater can be shut off during exhaust cycle, while fan continues to run.

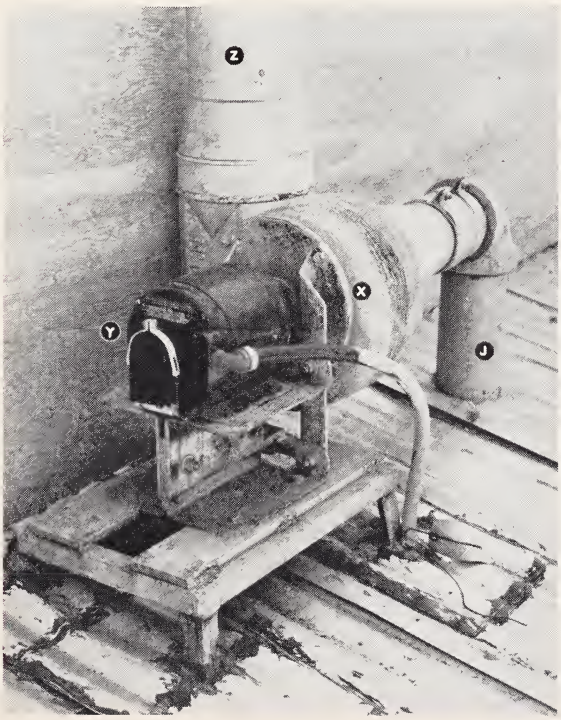


Figure 8. Exhaust fan on roof that shelters fumigator.
X. Squirrel-cage fan, 250 CFM capacity.
Y. 1/3-horsepower motor for fan.
Z. Exhaust stack, 6 inches in diameter, 10 feet in height. Duct J is continuation of duct shown in figure 4. Stack should discharge fumes well above nearby buildings.

CALIFORNIA CERTIFICATION REQUIREMENTS

The California State Department of Agriculture has established basic requirements of performance for methyl bromide fumigators to be used for fumigation of nursery stock. Certain of those requirements are as follows:

Gas retention. Loss of fumigant must not exceed 5 per cent after 1 hour or 10 per cent at 2 hours. The fumigator described here showed a loss of only 2 per cent at 1 hour. No 2-hour test was therefore necessary.

Temperature. Variance at several points inside the box must not exceed 2° F. In the model described, temperature variance in the empty chamber was reduced to ±1° F at several locations. Circulation from the false-floor joists converging toward the recirculation fan, and air turbulence resulting from forcing of air out of the heater duct made this narrow temperature fluctuation possible.

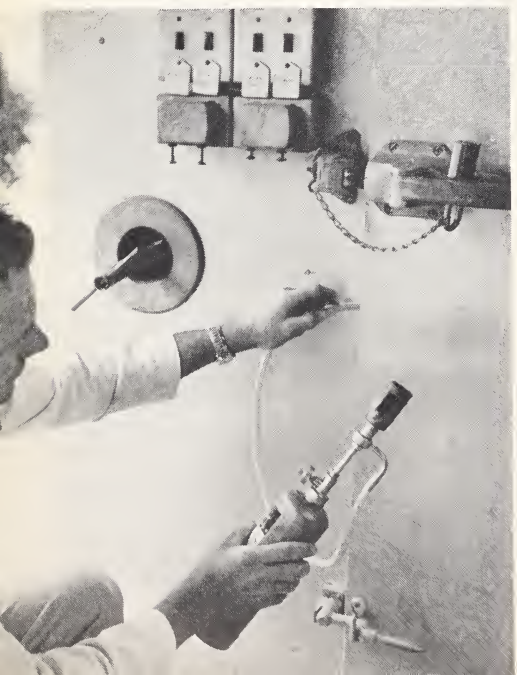
Details of the State requirements are given in *Requirements and Suggested Specifications for an Approved Atmospheric Fumigation Chamber*, by EARLE T. GAMMON. **Cir. E-10** (rev. May 1. 1959). Calif. State Dept. Agr., Sacramento.

Humidity. For living plants, relative humidity should be at least 75 per cent. This requirement is met by means of the warm-water bath (see fig. 7).

The fumigator herein described has met the construction and performance requirements of the California State Department of Agriculture and accordingly was certified as an "approved atmospheric fumigation chamber" on June 4, 1958.

MAINTENANCE

Figure 9. **Testing for leaks with a halide torch. Flame burns yellow to green to indicate lesser or greater amount, respectively, of escaping methyl bromide gas.**



Proper maintenance ensures that the box remains gas-tight and the various mechanical features function correctly.

Inspections for gas leaks around openings should be made monthly, by means of a halide torch (see fig. 9). Gas loss can be measured by a metering device (see Circular E-10 reference, above). With normal use, door gaskets should remain serviceable for three years.

Strip heaters are easily corroded by methyl bromide. Although they can be used for two and one-half years, their heating capacity is reduced noticeably after two years, and they should be replaced at that point.

The thermometer's brass jacket may be chrome plated to prolong its usefulness.

Maintenance requirements are low-cost and simple. Any good handyman can take care of them.

HOW TO OPERATE THE FUMIGATOR

The following instructions should be posted in a prominent place on the fumigator. (Explanations in parentheses are for readers of this circular, and may be omitted from the posted instructions.)

INSTRUCTIONS FOR USE OF THIS FUMIGATOR

Do not alter sequence of procedure

Fumigation

1. Material that has been in cold storage should be preheated, either in the fumigator or, preferably, by letting it stand in a warm room for several hours, or overnight, before it is put into the fumigator. This reduces time the fumigator is in use, increases effectiveness of the fumigant, and prevents condensation of moisture on the material, with subsequent tissue breakdown.

   When heater pilot light (connected to inside thermoswitch) goes off, check temperature on thermometer. Make certain air inlet is closed tight.
2. Check record sheet to make sure fumigator is not in use. (Warning lights that are activated by predetermined concentrations of fumigant are available, but were not installed on the box described here.)
3. Unlock door and place material in fumigator.
4. Fill water bath.
5. Close and padlock door. (The padlock is keyed to match doors leading into the insectary.)
6. Close exhaust valve by rotating chain-driven wheel in a clockwise direction until just snug. (Excessive force may cause the valve to jamb shut as gate is forced out bottom of valve.)
7. Close air inlet. (If thermometer indicates temperature 10 degrees or more below 80° F, the air inlet should remain open a crack until the air temperature inside the box has reached 80° F. This procedure prevents a marked increase of air pressure which would tend to force fumigant out of the box.)
8. Turn on recirculating fan.
9. Turn on heater. Air switch inside box is set for 80° F.
10. Add fumigant. (See separate instructions for operation of methyl bromide applicator.)

    Caution: In the interest of safety, an observer should be on hand while fumigant is being admitted to the fumigator as well as when the change-over to exhaust cycle is made. For safety reasons, it is particularly important not to change the sequence of procedure at these two times.

    Methyl bromide dosage: 26.5 ml per 100 cu. ft. = 1 lb. (265 ml) per 1,000 cu. ft. Usual dosage is 2 lb. (530 ml) per 1,000 cu. ft., or, for a 250-cu. ft. box, 133 ml.

    Time: 2 hours at 80° F, or as specified for particular plant or pest species.
11. Recheck to see that all valves on applicator and valve on the methyl bromide tank are shut off tight.
12. Record time on the record sheet.

HOW TO OPERATE

THE METHYL BROMIDE APPLICATOR

(The following procedure applies to the specific applicator on the fumigator at Riverside, and may not necessarily apply to other makes or models.)

Before admitting fumigant to the applicator, make certain that the three valves on the applicator and the one on the methyl bromide tank are shut off tight.

To refill graduated cylinder:

1. Open smallest valve on applicator.
2. Open upper valve on applicator.
3. Open valve on methyl bromide tank. Allow graduated glass cylinder to fill to desired level of approximately 200 ml, then shut off valve on tank. (Pressure in the cylinder forces the liquid fumigant into the fumigator.) *Note:* Pressure in the glass cylinder results from volatilization of the fumigant, which is accelerated at warm temperatures. On cool days, do not fill the cylinder to its maximum capacity.
4. Close upper valve on applicator.
5. Close smallest valve on applicator.

To admit fumigant into fumigator:

1. Open valve farthest to the left on applicator.
2. Close it when proper amount of fumigant has left graduated cylinder.

INSTRUCTIONS FOR EXHAUST PROCEDURE

1. Open exhaust valve by rotating chain-driven wheel counter-clockwise.
2. Turn heater off. Recirculating fan will continue to run.
3. Open air inlet valve.
4. Turn on exhaust fan.
5. Record time on log sheet.
6. Allow to exhaust for 60 minutes.
7. Unlock door and remove material.
8. Relock box, with door ajar.

Except during loading or unloading, the fumigator must be locked shut, as in step 8, above. (California law provides that unused household refrigerators, walk-in storage boxes, and the like, either must be kept locked shut or their doors must be removed to prevent persons from becoming trapped and possibly suffocated.)

Post on outside of fumigator:

FIRST AID

In case of accident, immediately begin treatment as follows:

If methyl bromide sprays onto clothing or shoes, remove contaminated articles at once and wash skin thoroughly with plain water, followed by soap and water. If skin comes into direct contact with the chemical, wash as directed above, first with plain water, then with soap and water. If methyl bromide gets into the eyes, wash them with water for at least 15 minutes.

Call a doctor.

CAUTION

THIS APPARATUS WAS DESIGNED SPECIFICALLY FOR USE WITH METHYL BROMIDE. OTHER FUMIGANTS MAY BE USED ONLY IF APPROPRIATE CHANGES ARE MADE IN THE HEATING AND HUMIDIFYING COMPONENTS.

NURSERY STOCK PLANTS THAT SHOW INITIAL INJURY FROM METHYL BROMIDE VAPORS BUT SOON RECOVER FULLY

Fumigate these plants when they are dormant, if possible. This applies especially to conifers.

(This list issued by California State Department of Agriculture, and revised from time to time.)

Acacia baileyana
A. decurrens
A. melanoxylon
A. verticillata
Azara microphylla
Calathea vandenheckei
Capsicum frutescens
Chamæcyparis lawsoniana
Cissus spp.
Clerodendron speciosissimum
Crassula spp.
Cupressus arizonica
C. macrocarpa
Cytisus racemosus
Elæagnus pungens
Erica mediterranea
Erica spp.
Erythrina crista-galli
Fatsia japonica (Aralia japonica)
Ficus pandurata
Fuchsia sp.
Genista monosperma
Geranium spp.
Hibiscus spp.
Hoya carnosa
Hydrangea macrophylla (hortensis)
Juniperus spp.
Kalanchoë spp.
Lantana spp.
Leonotis leonurus
Maranta spp.
Myrtus communis
Nerium oleander
Osmanthus ilicifolius (aquifolium)
Pandanus veitchii
Pelargonium spp.
Philodendron cordatum
P. pertusum
P. scandens
Pittosporum eugenioides
P. tenuifolium
P. tobira
P. viridiflorum
Psidium guajava
Solanum pseudo-capsicum
Spartium junceum

NURSERY STOCK PLANTS NONTOLERANT OF METHYL BROMIDE VAPORS

(This list issued by California State Department of Agriculture, and revised from time to time.)

Abelia grandiflora
Adiantum spp. (Maidenhair-fern)
Areca palm
Asplenium nidus
Aster fruticosus
Azalea varieties Coral Bells and Salmon Queen
Begonia semperflorens
B. tuberhybrida (plants)
Celosia cristata (cockscomb)
Chamæcyparis lawsoniana var. *allumii*
C. lawsoniana var. *erecta viridis*
C. nootkatensis
Chrysanthemum spp.
Coleus blumei
Cuphea hyssopifolia
Cupressus sempervirens
Fremontia californica
Griselinia littoralis
Lavandula pedunculata
Musa spp.
Osmanthus americanus
Poinsettia
Polystichum (Holly fern)
Saintpaulia ionantha
Sedum adolphii
Sinningia speciosa (gloxinia)
Stephanotis floribunda

EXAMPLES OF CONTAMINANTS FOUND ON VARIOUS HOST PLANTS AT RIVERSIDE

Host plant or substrate	*Intended as host for:*	*Contaminants*
Potato tubers	Certain diaspine scales	Potato tuber worm, tomato pinworm, mealybug
Potato sprouts	Lecanine scales, mealybugs	Same as above
Oleander plants	Lecanine scales	Miscellaneous diaspine and lecanine scales, mealybugs, aphids, and miscellaneous predators and parasites thereof
Cereals, dry-processed or whole grain	*Ephestia, Sitotroga, Tenebrio,* and other stored-products pests	Miscellaneous stored-products pests
Citrus fruit or plants	Citrus pests in general, i.e., mites, scale, mealybugs, aphids	General pests of citrus and their natural enemies
Citron melons and banana squash	Mealybugs, scale, mites	Mealybugs, scale, mites, and natural enemies thereof

ACKNOWLEDGMENTS

The virtually trouble-free performance of the fumigator at Riverside is largely the result of the sound advice of specialists who gave freely of their time and talents during its design and construction. The contributions of the following persons are gratefully acknowledged: D. L. Lindgren, Department of Entomology, Riverside; Cyril Gammon, California State Department of Agriculture, Bureau of Entomology; Harry E. Gillespie, Craft Foreman, Department of Buildings and Grounds, Riverside, who supervised construction of the fumigator; and Max E. Badgley, Department of Biological Control, Riverside, who assisted in the planning and worked out certain innovations after initial completion of the box.

In order that the information in our publications may be more intelligible it is sometimes necessary to use trade names of products or equipment rather than complicated descriptive or chemical identifications. In so doing it is unavoidable in some cases that similar products which are on the market under other trade names may not be cited. No endorsement of named products is intended nor is criticism implied of similar products which are not mentioned.

Co-operative Extension work in Agriculture and Home Economics, College of Agriculture, University of California, and United States Department of Agriculture co-operating. Distributed in furtherance of the Acts of Congress of May 8, and June 30, 1914. George B. Alcorn, Director, California Agricultural Extension Service.

6½*m*-2,'63 (D4151) L.L.